Environmental radioactivity in the Faroes in 1975

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FOOD
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MILK
PLANTS
RADIOACTIVITY
SEAWATER
SHEEP

[1] ATMOSPHERIC PRECIPITATIONS
BONE TISSUES
DRINKING WATER
MAN
STRONTIUM 90

[2] CESIUM 137

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Environmental Radioactivity in the Faroes in 1975

by

A. Aarkrog and J. Lippert

Research Establishment Risø
Health Physics Department

Abstract

Measurements of fall-out radioactivity in the Faroes in 1975 are presented. Strontium-90 (and ^{137}Cs in most cases) was determined in regularly collected samples of precipitation, grass, milk, fish, sea water, bread, and drinking water. In addition, analyses were made of spot samples of lamb, whale, sea birds, potatoes, sea plants, vegetables, eggs, and human bone. Estimates are given of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faroes in 1975.

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CONTENTS

ABBREVIATIONS AND UNITS

FP	fission products
pCi	picocurie, 10^{-12} Ci $\mu\mu$Ci
nCi	nanocurie, 10^{-9} Ci, mμCi
mCi	millicurie, 10^{-3} Ci
MPC	maximum permissible concentration
S. U.	pCi ^{90}Sr/g Ca
O. R.	observed ratio
M. U.	pCi ^{137}Cs/g K
n Sr	natural (stable) Sr
S. D.	standard deviation, $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{(n-1)}}$
S. E.	standard error, $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{n(n-1)}}$
S. S. D.	sum of squares of deviations, $\Sigma(\bar{x}-x_i)^2$
f	degrees of freedom
s^2	variance
v^2	ratio between the variance in question and the residual variance
P	probability fractile of the distribution in question
$\bar{x}$	mean values
Σ	sum
η	coefficient of variation, relative standard deviation
A:	η : 20-33%
B:	η: $>$ 33%
B. D. L.	below detection limit

1. INTRODUCTION

1.1.

The fall-out programme for the Faroes, which was initiated in 1962[1] in close co-operation with the National Health Service and the chief physician of the Faroes, was continued in 1975. Samples of human bone were obtained in 1975 from Dronning Alexandrine's Hospital in Thorshavn.

1.2.

The present report will not repeat information concerning sample collection and analysis already given in Risø Reports Nos. 64, 86, 108, 131, 155, 181, 202, 221, 246, 266, 292, 306 and 324[1].

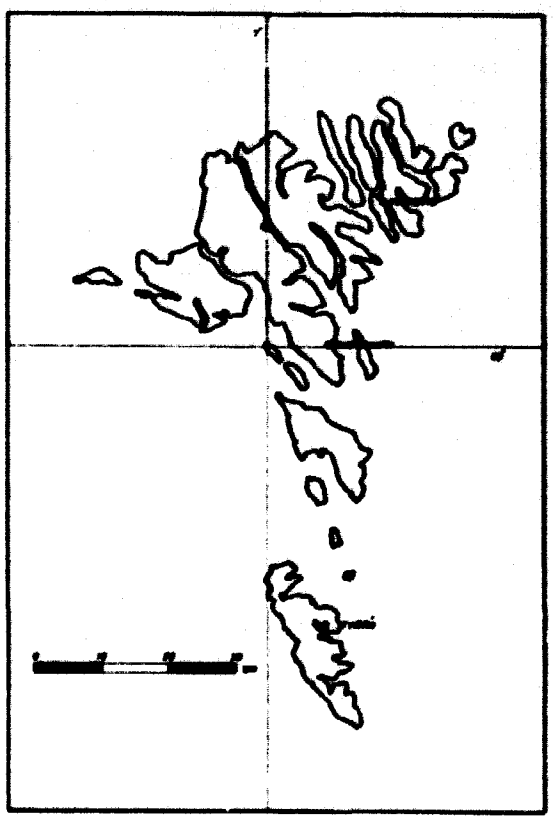

Fig. 2.1.1. The Faroes.

1.3.

The estimated mean diet of the Faroese as used in this report is still based on the estimate given by Professor E. Hoff-Jørgensen, Ph.D., in 1962.

1.4.

The present investigation was carried out together with corresponding examinations of fall-out levels in Denmark and Greenland, described in Risø Reports Nos. 345[2] and 347[3] respectively.

2. RESULTS AND DISCUSSION

2.1. Strontium-90 in Precipitation

Table 2.1 shows the ^{90}Sr content in precipitation collected at Høyvig (near Thorshavn) and Klaksvig in 1975. The amount of precipitation at Klaksvig was a factor of 1.3 greater than that found at Høyvig, and the amount of fall-out at Klaksvig was 1.4 times that measured at Høyvig.

The mean activity of ^{90}Sr in precipitation in 1975 was approx. equal to the 1974 levels in the Faroes. The amount of precipitation was somewhat lower in 1975 than in 1974, especially at Klaksvig.

Table 2.1

Strontium-90 in precipitation in the Faroes in 1975

Month	Høyvig		Klaksvig	
	pCi $^{90}Sr/l$	mCi $^{90}Sr/km^2$	pCi $^{90}Sr/l$	mCi $^{90}Sr/km^2$
Jan.	0.31	0.113	0.64	0.157
Feb.	1.65	0.118	1.95	0.333
Mar.	3.86 A	0.046 A	5.10	0.105
Apr.	2.20	0.101	2.63	0.132
May	1.56	0.086	1.43	0.115
June	1.12	0.084	1.92	0.137
July	1.51	0.042	1.51	0.030
Aug.	0.81	0.040	1.67 A	0.064 A
Sep.	0.70	0.127	0.95 A	0.044 A
Oct.	0.51	0.066	0.24	0.059
Nov.	1.06 B	0.022 B	0.40 A	0.040 A
Dec.	0.32 B	0.084 B	0.28 A	0.076 A
1975	$\bar{x}$ 0.87	Σ 0.929 Σ_{min} 1071	$\bar{x}$ 0.95	Σ 1.292 Σ_{min} 1360

2.2. Strontium-90 and Caesium-137 in Grass

Grass samples were collected near Thorshavn in 1975. Table 2.2 shows the results. The mean S.U. content of the grass during the summer months was estimated at 150 S.U., and the mean S.U. in milk during June-September was 16.7 S.U. at Thorshavn (cf. 2.3), i.e., the observed ratio between the S.U. in milk and in grass was 0.11 (mean 1965-75 0.10 ± 0.01 (1 S.E.) fig. 2.2). The 1975 S.U. levels in grass were 0.6 times the 1974 levels. As compared with Danish grass in 1975[2], we found the S.U. levels in the Faroese grass to be higher by a factor of approx. 3.4 in the summer months.

The mean ratio between ^{137}Cs and ^{90}Sr in the grass (pCi/g ash) was 2.6 in 1975. (Mean 1965-75: 2.3 ± 0.2).

Table 2.2

Strontium-90 and Caesium-137 in grass from Thorshavn 1975

Month	pCi ^{90}Sr/g ash	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/g ash	$^{137}Cs/^{90}Sr$
June	5.3	121	12.6	2.38
Aug.	4.5	179	13.0	2.89

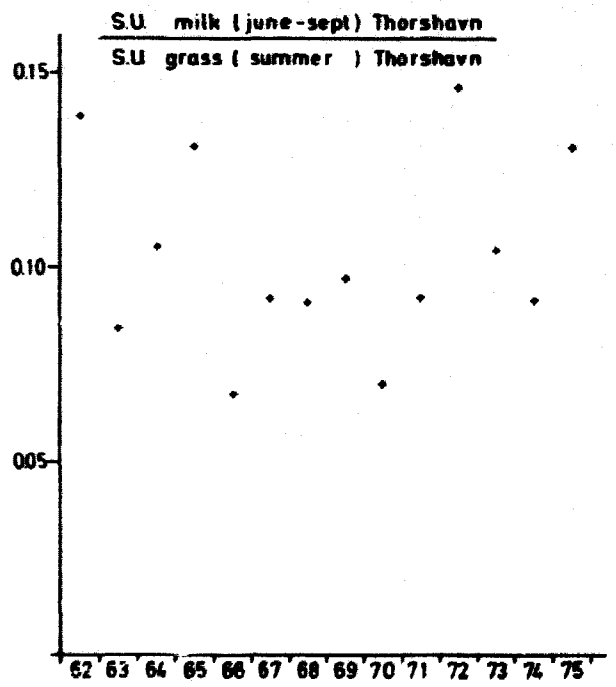

Fig. 2.2. The observed ratio between S.U. in milk and grass collected in the summer month at Thorshavn 1962-75.

2.3. Strontium-90 and Caesium-137 in Milk

As in previous years[1], weekly samples of fresh milk were obtained from Thorshavn, Klaksvig, and Tvørå. Strontium-90 and ^{137}Cs were determined in bulked monthly samples.

Table 2.3.1 shows the results and tables 2.3.2, 2.3.3 and 2.3.4 the analysis of variance of the S.U., M.U., and pCi ^{137}Cs/l figures respectively. The variation between months was not significant. As also observed in previous years, the variation between locations was significant. The highest ^{137}Cs and ^{90}Sr levels were found in the milk from Tvørå and Klaksvig and the lowest in the Thorshavn milk.

Figure 2.3.1 shows the quarterly S.U. values and fig. 2.3.2 the quarterly pCi ^{137}Cs/l levels since 1962. The annual mean values for 1975 were 19 S.U. (~23 pCi ^{90}Sr/l) and 117 M.U., or 198 pCi ^{137}Cs/l, i.e. the ^{90}Sr levels in 1975 were nearly equal to the 1974 mean levels, the ^{137}Cs levels were somewhat lower.

The annual mean values of the M.U./S.U. ratio in Faroese milk are shown in fig. 2.3.3.

The mean M.U./S.U. ratio in 1975 was 6.3 ± 0.3 during the grazing period (May-October), and in the winter time it was 6.0 ± 0.4. This is in agreement with previous observations[1].

Figure 2.3.4 shows a comparison between the ^{90}Sr and ^{137}Cs levels in Faroese- and Danish-produced milk. It is evident that soil uptake plays an

Table 2.3.1

Strontium-90 and Caesium-137 in milk from the Faroes in 1975

Month	Thorshavn			Klaksvig			Tvørå			Mean		
	S.U.	pCi ^{137}Cs/l	M.U.	S.U.	pCi ^{137}Cs/l	M.U.	S.U.	pCi ^{137}Cs/l	M.U.	S.U.	pCi ^{137}Cs/l	M.U.
Jan.	13.3	106	62	22	221	131	27	494	274	21	274	156
Feb.	16.6	119	71	12.0	74	45	24	238	145	17.5	144	87
Mar.	17.1	109	68	22	172	110	21	310	193	20	197	124
Apr.	12.6	126	72	16.5	155	97	36	309	188	22	197	119
May	16.5	102	62	15.0	206	127	24	310	182	18.5	206	124
June	14.4	101	60	23	175	104	27	359	200	21	212	121
July	16.2	120	73	17.8	182	113	30	305	181	21	202	122
Aug.	21	206	117	21	190	110	26	427	242	23	274	156
Sep.	15.3	140	83	13.4	237	139	25	302	175	17.9	226	132
Oct.	15.6	113	67	13.1	134	78	22	215	128	16.9	154	91
Nov.	13.6	101	62	10.8	163	95	15.0	197	117	13.1	154	91
Dec.	13.1	104	64	16.9	152	91	16.8	139	83	15.6	132	79
Mean	15.4	121	72	17.0	172	103	24.5	300	176	19.0	198	117

important role for the ^{137}Cs levels in the Faroes. The ratios between the ^{90}Sr levels in Faroese and Danish milk have shown a tendency to decrease through the years.

Table 2.3.2

Analysis of variance of ln pCi ^{90}Sr/g Ca in Faroese milk in 1975
(from table 2.3.1)

Variation	SSD	f	s^2	v^2	P
Betw. months	0.742	11	0.067	1.750	-
Betw. locations	1.446	2	0.723	18.771	>99.95%
Remainder	0.847	22	0.039		

Table 2.3.3

Analysis of variance of ln pCi ^{137}Cs/g K in Faroese milk in 1975
(from table 2.3.1)

Variation	SSD	f	s^2	v^2	P
Betw. months	1.306	11	0.119	2.068	-
Betw. locations	4.951	2	2.475	43.122	>99.95%
Remainder	1.263	22	0.057		

Table 2.3.4

Analysis of variance of ln pCi ^{137}Cs/l Faroese milk in 1975
(from table 2.3.1)

Variation	SSD	f	s^2	v^2	P
Betw. months	1.443	11	0.131	2.168	-
Betw. locations	5.086	2	2.543	42.033	>99.95%
Remainder	1.331	22	0.061		

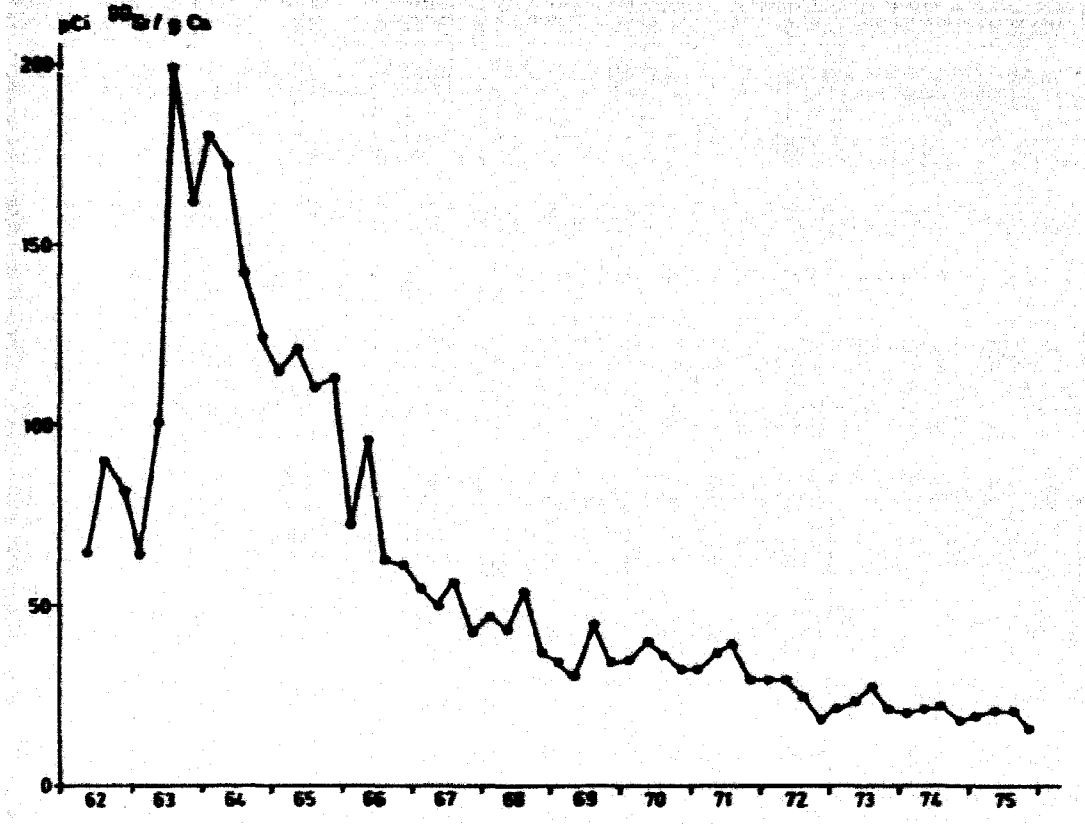

Fig. 2.3.1. Strontium-90 in Faroese milk 1962-75.

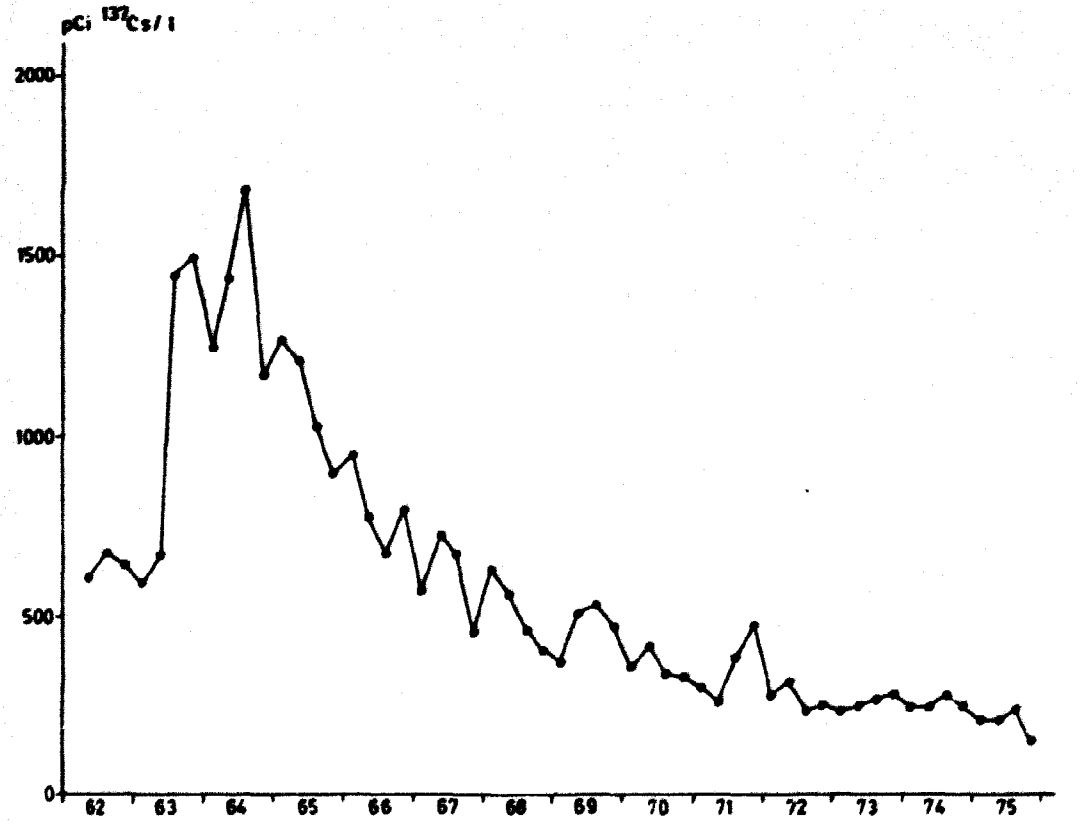

Fig. 2.3.2. Caesium-137 in Faroese milk 1962-75.

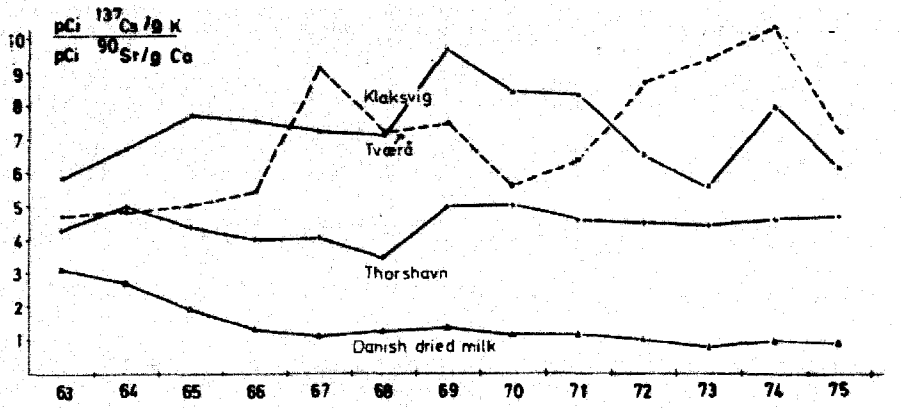

Fig. 2.3.3. $\frac{\text{M.U.}}{\text{S.U.}}$ ratios in Faroese and Danish milk 1963-75.

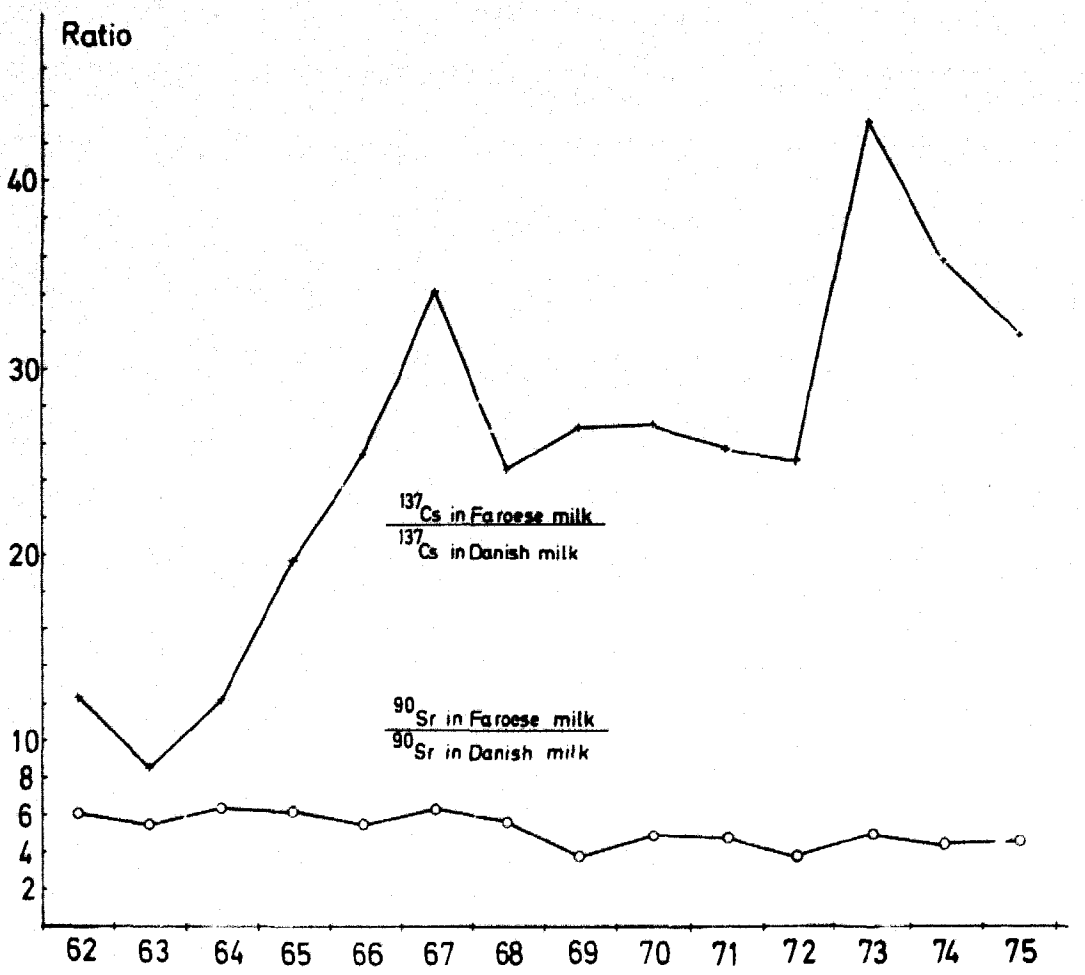

Fig. 2.3.4. A comparison between Faroese and Danish milk levels, 1962-75.

2.4. Strontium-90 and Caesium-137 in Terrestrial Animals

Lamb meat and bone were obtained from 3 locations in 1975 and sheep (7 years old) from 1 location.

The mean levels for lamb meat were 19 pCi ^{90}Sr/kg, or 133 S.U., and 2.57 nCi ^{137}Cs/kg, or 980 M.U. The bone level was 155 pCi ^{90}Sr/g Ca. As compared with 1974, the mean levels were somewhat higher in 1975.

Table 2.4

Strontium-90 and Caesium-137 in lamb and sheep samples from the Faroes in 1975

Location	Sample type	pCi ^{90}Sr/kg	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/kg	pCi ^{137}Cs/g K
Høyvik	Lamb meat	16.0	104	782	197
Høyvik	Lamb bone	-	103	-	-
Tværå	Lamb meat	25	167	4657	2013
Tværå	Lamb bone	-	222	-	-
Klaksvig	Lamb meat	16.0	129	2285	734
Klaksvig	Lamb bone	-	139	-	-
Høyvik	Mutton	10.4	83	440	160
Høyvik	Sheep bone	-	128	-	-

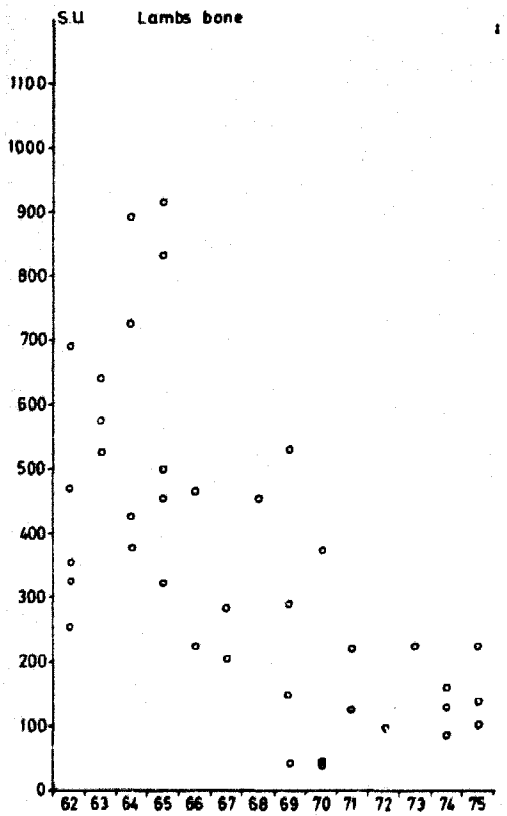

Fig. 2.4.1. S.U. in lamb bone collected in the Faroes 1962-75.

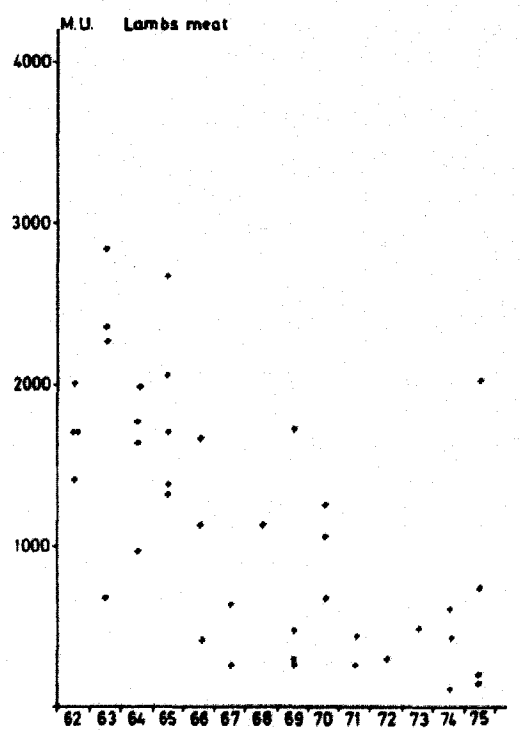

Fig. 2.4.2. M.U. in lamb meat collected in the Faroes 1962-75.

2.5. Strontium-90 and Caesium-137 in Sea Animals

Table 2.5.1 shows the ^{90}Sr and ^{137}Cs levels in fish, whale and birds collected in 1975 in the Faroes. The mean levels in Gadus aeglefinus and Gadus callarias were 0.27 pCi ^{90}Sr/kg (S.E.: 0.12) and 8 pCi ^{137}Cs/kg (S.E.: 0.5). Whale contained 0.44 pCi ^{90}Sr/kg and 19 pCi ^{137}Cs/kg.

Table 2.5.1

Strontium-90 and Caesium-137 in sea animals from the Faroes in 1975

Sampling months		Species	Sample type	pCi ^{90}Sr/kg	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/kg	pCi ^{137}Cs/g K
Jan.	Fish	Gadus aeglefinus	Meat	0.13 B	1.1 B	6.6	1.2
Jan.	"	Gadus callarias	Meat	0.10 A	1.0 A	8.7	2.5
Apr.	Fish	Gadus aeglefinus	Meat	0.12 A	0.9 A	8.0	1.9
Apr.	"	Gadus callarias	Meat	0.14 B	1.3 B	10.1	2.8
June	Fish	Gadus aeglefinus	Meat	0.17	1.2	6.8	2.0
June	"	Gadus callarias	Meat	0.16 B	1.5 B	10.0	2.6
Nov.	Fish	Gadus aeglefinus	Meat	0.24 A	3.5 A	7.1	(1.8)
Nov.	"	Gadus callarias	Meat	1.11	6.7	7.0	(1.8)
Aug.	Fish	Salmo iridius	Meat	4.5	5.6	21	5.3
Aug.	"	Salmo iridius	Bone	-	8.6	-	-
July	Whale	Globicephala melaena	Meat	0.44 B	1.2 B	19.3	5.4
July	Whale	Globicephala melaena	Bone	-	0.04 B	-	-
June	Bird	Fratercula arctica	Meat	1.5 B	19.7 B	9.7 B	2.7 B
June	"	Fratercula arctica	Bone	-	0.03 B	-	-
June	Bird	Guillemot	Meat	0.7 B	14.4 B	10.3	2.7
June	"	Guillemot	Bone	-	0.07 B	-	-

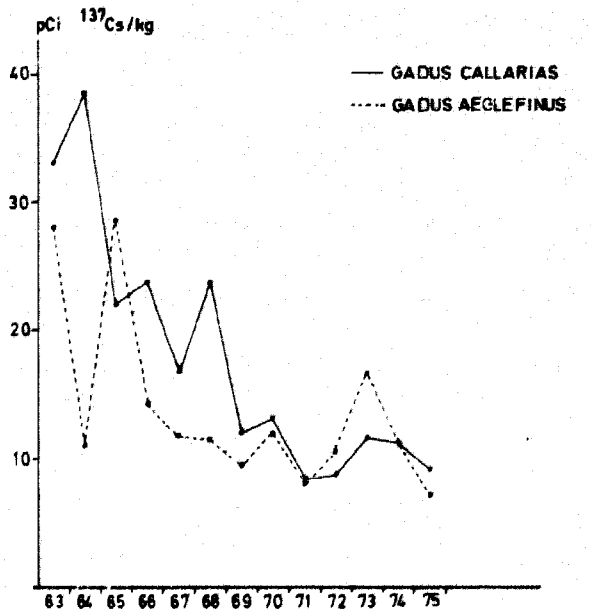

Fig. 2.5.1. Caesium-137 levels in meat of Cod and Haddock collected in the Faroes 1962-75.

2.6. Strontium-90 in Drinking Water

Drinking-water samples were collected as previously[1]. Table 2.6.1 shows the results and table 2.6.2 the analysis of variance. As in previous years, drinking water from Thorshavn contained more ^{90}Sr than that from Tværå (cf. the explanation in Risø Report No. 181[1]).

Figure 2.6.1 shows the bimonthly mean levels of ^{90}Sr in drinking water from the three locations since 1962.

The mean level in 1975 was 0.37 pCi $^{90}Sr/l$, i.e. nearly unchanged from the 1974 level.

Table 2.6.1

Strontium-90 in drinking water from the Faroes in 1975
pCi $^{90}Sr/l$

Month	Thorshavn	Klaksvig	Tværå
Jan.	0.67	0.18	0.37
Mar.	0.83	0.31	0.38
May	0.70	0.21	0.31
July	0.53	0.23	0.32
Sep.	0.49	0.21	0.21
Nov.	(0.33)	0.10	0.18 A
1975	0.59	0.21	0.30

Figures in brackets calculated from VAR3[12].

Table 2.6.2

Analysis of variance of ln pCi $^{90}Sr/l$ drinking water in 1975
(from table 2.6.1)

Variation	SSD	f	s^2	v^2	P
Betw. months	1.112	5	0.222	9.364	>99.5%
Betw. locations	3.209	2	1.604	67.527	>99.95%
Remainder	0.214	9	0.024		

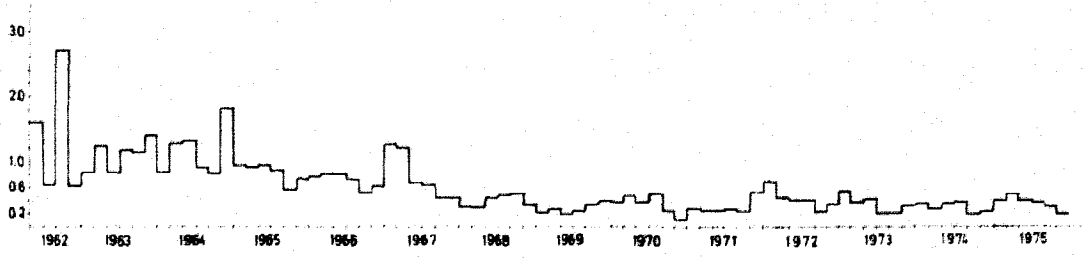

Fig. 2.6.1. Strontium-90 in drinking water, 1962-75 (mean of Thorshavn, Klaksvig and Tværå).

2.7. Strontium-90 and Caesium-137 in Miscellaneous Samples

2.7.1. Soil

No soil samples were collected in 1975 from the Faroes. From earlier years observations we estimate the accumulated fall-out at Thorshavn to be 64 mCi $^{90}Sr/km^2$ and that at Klaksvig to be 129 mCi $^{90}Sr/km^2$.

2.7.2. Sea Water

Surface sea water was collected near Thorshavn on four occasions in 1975. The ^{90}Sr mean level was 0.10 pCi $^{90}Sr/l$. (1 S.E.: 0.01).

Figure 2.7.2 shows the ^{90}Sr levels since 1962.

The samples were also analysed for ^{137}Cs. The mean was 0.23 ± 0.03 pCi $^{137}Cs/l$. The $^{137}Cs/^{90}Sr$ ratio was: 2.4 ± 0.5.

North Sea water collected in 1975 showed a mean ratio of 1.8 (cf. Risø Report No. 345[2], and also Risø Report No. 347[3]).

Table 2.7.2

Strontium-90 and Caesium-137 in sea water from the Faroes in 1975

Sampling month	^{90}Sr pCi/l	^{137}Cs pCi/l	Salinity o/oo
Mar.	0.13	0.16 B	34.8
June	0.10	0.20 B	34.8
Aug.	0.10	0.31	35.4
Nov.	0.07	0.24 A	34.9

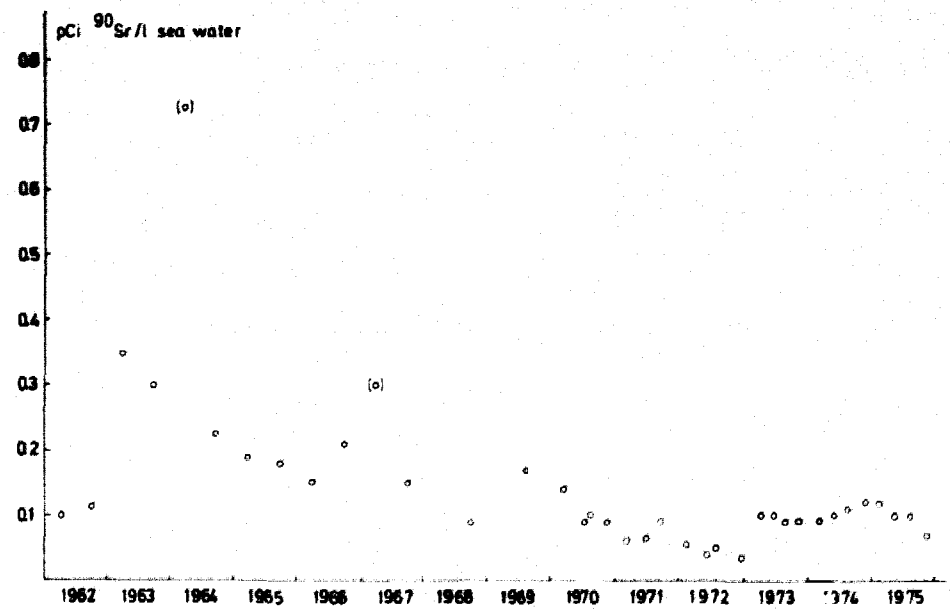

Fig. 2.7.2. Strontium-90 in Faroese seawater 1962-75.

2.7.3. Sea Plants

Two samples of laminaria were obtained in 1975. Table 2.7.3 shows the ^{90}Sr and the ^{137}Cs determinations.

Table 2.7.3

Strontium-90 and Caesium-137 in sea plants from the Faroes in 1975

Sampling month	Species	pCi ^{90}Sr/g ash	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/g ash	pCi ^{137}Cs/g K
June	Laminaria	0.84	7.0	0.248	2.4
Aug.	Laminaria	1.87	13.7	B.D.L.	B.D.L.

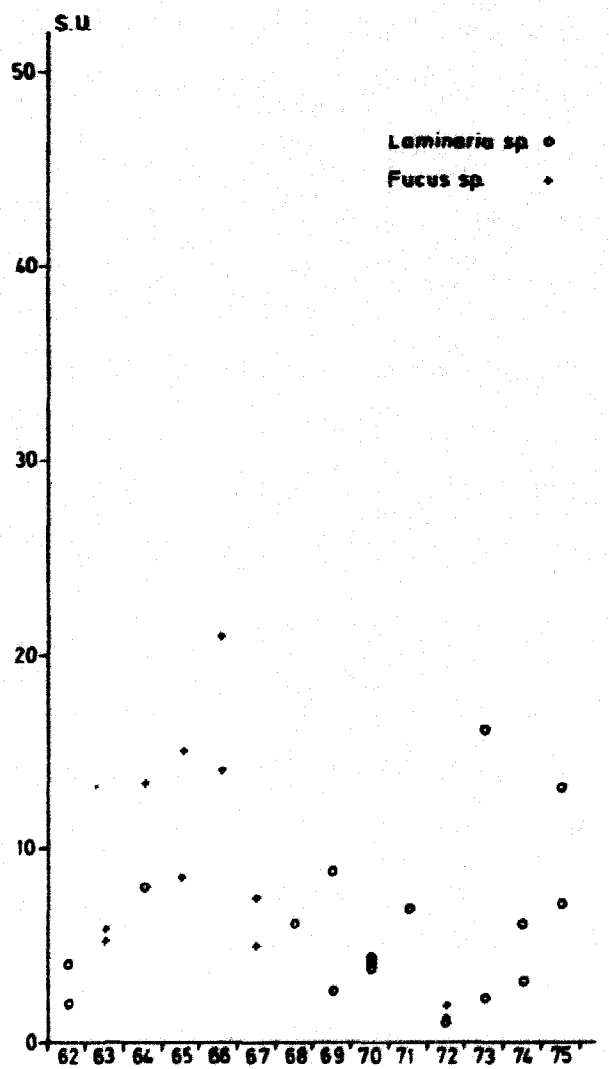

Fig. 2.7.3. S.U. in seaplants collected at Thorshavn 1962-75.

2.7.4. Vegetables

Tables 2.7.4.1 and 2.7.4.2 show the results of the ^{90}Sr and ^{137}Cs determinations.

As last year potatoes were obtained from Thorshavn (Høyvik), Klaksvig and Tværå. The mean levels were not significantly different from those in 1974. For the period 1968-75 we may use a constant level equal to the average for this period, i.e. 320 pCi ^{137}Cs/kg potatoes and 9.5 pCi ^{90}Sr/kg.

Table 2.7.4.1

Strontium-90 and Caesium-137 in vegetable and fruits from the Faroes in 1975

Sampling month	Species	pCi ^{90}Sr/kg	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/kg	pCi ^{137}Cs/g K
Aug.	Carrots	7.8	-	B.D.L.	B.D.L.
Aug.	Cauliflower			4.5 B	-
Aug.	Berries	14.5	-	13.3	-

Table 2.7.4.2

Strontium-90 and Caesium-137 in potatoes from the Faroes in October 1975

Location	pCi ^{90}Sr/kg	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/kg	pCi ^{137}Cs/g K
Høyvig	11.2	363	227	56
Klaksvig	12.9	418	206	61
Tværå	10.9	404	541	109

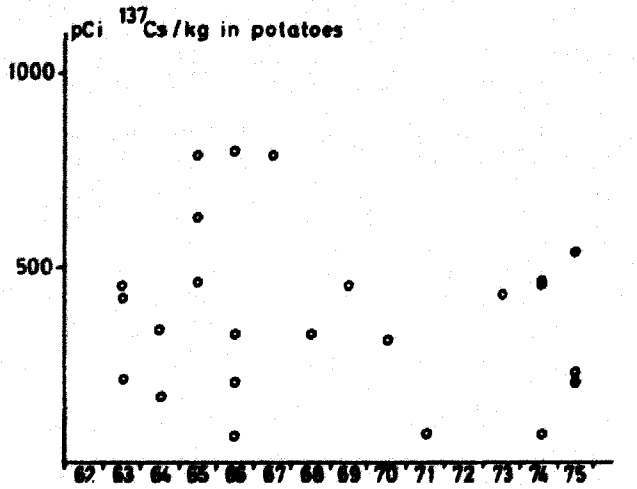

Fig. 2.7.4.1. Caesium-137 in Faroese potatoes collected 1962-75.

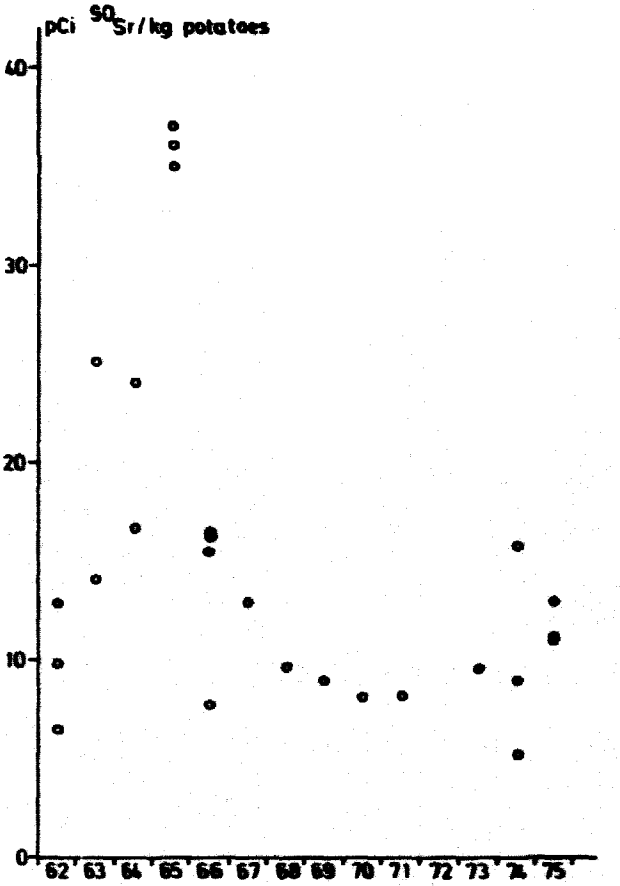

Fig. 2.7.4.2. Strontium-90 in Faroese potatoes collected 1962-75.

2.7.5. Bread

As in previous years[1], rye bread and white bread were collected at Thorshavn in June and December. The mean levels in white bread were 4.2 pCi ^{90}Sr/kg and 5.2 pCi ^{137}Cs/kg. The rye bread collected in 1975 contained on the average 12 pCi ^{90}Sr/kg and 16 pCi ^{137}Cs/kg, i.e. the bread levels were nearly equal to the 1974 levels. The ^{90}Sr and ^{137}Cs levels in Faroese bread were lower than the Danish[2].

Table 2.7.5

Strontium-90 and Caesium-137 in Faroese bread in 1975

Month	Sort	pCi ^{90}Sr/kg	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/kg	pCi ^{137}Cs/g K
June	White bread	4.7	4.1	6.8 A	4.9 A
June	Rye bread	14.4	7.1	20.2	9.2
Dec.	White bread	3.6	4.7	3.7 A	2.5 A
Dec.	Rye bread	10.0	6.6	11.5	4.9

2.7.6. Eggs

Eggs were collected from Thorshavn in June and December 1975. Table 2.7.6 shows the results. The mean levels were 1.4 pCi ^{90}Sr/kg (2.4 S.U.) and 8 pCi ^{137}Cs/kg, i.e. unchanged from last year.

Table 2.7.6

Strontium-90 and Caesium-137 in Faroese eggs in 1975

Month	pCi ^{90}Sr/kg	pCi ^{90}Sr/g Ca	pCi ^{137}Cs/kg	pCi ^{137}Cs/g K
June	1.7	2.8	11.1	7.7
Dec.	1.1	1.9	4.4 B	3.1 B

2.7.7. Butter

The ^{90}Sr content was measured in a sample of butter collected in the Faroes in 1975. We found 1 pCi ^{90}Sr/kg butter (9.9 S.U.) and 6 pCi ^{137}Cs/kg (36 M.U.).

2.8. Humans

2.8.1. Strontium-90 in Human Bone

In 1975 eleven human bone samples were analysed from Dronning Alexandrine's Hospital in Thorshavn. Table 2.8.1 shows the results.

The mean level in bone of newborn infants was 2.5 pCi ^{90}Sr/g Ca, and from Danish measurements since 1963 we know that the observed ratio between the bone of newborn infants and the mothers' diet is 0.11. Hence, the mothers' diet should have contained approx. 23 pCi ^{90}Sr/g Ca. In

Table 2.8.1

Strontium-90 in human vertebrae collected in the Faroes in 1975

Age	Month of death	Sex	pCi ^{90}Sr/g Ca
~ 0	~ 9	F	2.46*
~ 5 days	~ 4	M	1.60*
26 years	4	F	5.45**
73 years	-	F	1.53
76 years	1	F	1.79 A

* Bulked sample from 4 individuals

** From Bergen in Norway

1974[1] the ^{90}Sr level of the Faroese adult human diet was estimated at 10 pCi ^{90}Sr/g Ca, and in 1975 we found (cf. 3) 10.4 pCi ^{90}Sr/g Ca. As the bone samples were collected in the last part of 1975, it is reasonable to conclude that the estimated diet level is approx. 11. As in 1974[1], it must be concluded that the levels in bone of newborn infants were higher than expected from the diet estimate. Similar observations have been made in Denmark[2]. The higher levels in newborn infants bone may be due to a transfer of ^{90}Sr from the mother's bone. Here the S.U.-levels in recent years have been close to levels in the bone of newborn infants.

3. ESTIMATE OF THE MEAN CONTENTS OF ^{90}Sr AND ^{137}Cs IN THE HUMAN DIET

3.1. Annual Quantities

The annual quantities are still based on the estimate made by Professor E. Hoff-Jørgensen, Ph.D., in 1962[1] of a daily per capita intake of approx. 3000 calories.

3.2. Milk and Cream

75% of the milk consumed in the Faroes is assumed to be of local origin, and 25% comes from Denmark. Hence the ^{90}Sr content in milk consumed in the Faroes in 1975 was $1.2 \cdot (0.75 \cdot 19 + 0.25 \cdot 4.1) = 18.3$ pCi ^{90}Sr/kg, and the ^{137}Cs content was $0.75 \cdot 198 + 0.25 \cdot 6.1 = 150$ pCi ^{137}Cs/kg (cf. 2.3 and ref. 2). 1 kg milk contains 1.2 g Ca.

3.3. Cheese

Nearly all cheese consumed in the Faroes is of Danish origin, and the Danish figures from ref. 2 were used: 34.7 pCi ^{90}Sr/kg and 4.4 pCi ^{137}Cs/kg.

3.4. Grain Products

As most grain products are imported from Denmark, the Danish figures for 1975[2] were used in the calculation of the Faroese levels. The mean daily consumption of grain products in the Faroes is, as in Denmark, 80 g rye flour, 120 g wheat flour, and 20 g grits. Hence the mean concentration of ^{90}Sr in grain products consumed in the Faroes in 1975 is 15 pCi ^{90}Sr/kg and 25 pCi ^{137}Cs/kg.

3.5. Potatoes

All potatoes consumed in the Faroes are assumed to be of local origin. The values from table 2.7.4.2 were used, i.e. 12 pCi ^{90}Sr/kg and 325 pCi ^{137}Cs/kg.

3.6. Other Vegetables and Fruit

As the amount of vegetables and fruit grown in the Faroes is limited, the Danish figures from 1975[2] were used. Thus the mean contents in vegetables other than potatoes were 11 pCi ^{90}Sr/kg and 3 pCi ^{137}Cs/kg, and the mean contents in fruit were 3 pCi ^{90}Sr/kg and 2 pCi ^{137}Cs/kg.

3.7. Meat and Eggs

Meat and egg consumption in the Faroes is estimated to consist of 50% locally-produced mutton (or lamb), 25% local whale meat, and 25% sea birds and eggs.

The mutton contained 19 pCi ^{90}Sr/kg and 2.57 nCi ^{137}Cs/kg (cf. 2.4). Whale meat from 1975 contained 0.44 pCi ^{90}Sr/kg and 19 pCi ^{137}Cs/kg, sea birds from 1975[1] and eggs (cf. 2.7.6): 1.1 pCi ^{90}Sr/kg and 1.4 pCi ^{90}Sr/kg, and 10 and 8 pCi ^{137}Cs/kg respectively.

Hence we estimate the mean content of ^{90}Sr in meat and eggs consumed in 1975 to be

$$0.50 \cdot 19 + 0.25 \cdot 0.44 + 0.25 \cdot \left(\frac{1.1 + 1.4}{2}\right) = 9.9 \text{ pCi } ^{90}Sr/kg$$

and the ^{137}Cs content to be

$$0.50 \cdot 2570 + 0.25 \cdot 19 + 0.25 \cdot 9 = 1292 \text{ pCi } ^{137}Cs/kg.$$

3.8. Fish

All fish consumed in the Faroes is of local origin, and the mean contents in fish, obtained from subsection 2.5, were 0.3 pCi ^{90}Sr/kg and 8 pCi ^{137}Cs/kg.

3.9. Coffee and Tea

The Danish figures for 1975[2] were used, i.e. 25 pCi ^{90}Sr/kg and 37 pCi ^{137}Cs/kg.

3.10. Drinking Water

The mean value found in table 2.6.1 was used, i.e. 0.37 pCi ^{90}Sr/l. The ^{137}Cs content was estimated to be approx. one fourth (the ratio found in New York tap water in 1964[4]) of the ^{90}Sr content, i.e. 0.1 pCi ^{137}Cs/l.

Tables 3.1 and 3.2 show the diet estimates of ^{90}Sr and ^{137}Cs respectively.

Table 3.1

Estimate of the mean content of ^{90}Sr in the human diet in the Faroes in 1975

Type of food	Annual quantity in kg	pCi ^{90}Sr per kg	Total pCi ^{90}Sr	Percentage of total ^{90}Sr in food
Milk and cream	146	18.3	2672	42.6
Cheese	7.3	34.7	253	4.0
Grain products	80	15	1200	19.1
Potatoes	91	12	1092	17.4
Vegetables	20	11	220	3.5
Fruit	18	3	54	0.9
Meat and eggs	37	9.9	366	5.9
Fish	91	0.3	27	0.4
Coffee and tea	7.3	25	182	2.9
Drinking water	548	0.37	203	3.3
Total			6269	

The mean annual calcium intake is estimated to be 600 g (approx. 200-250 g of creta praeparata). Hence the pCi ^{90}Sr/g Ca ratio in the total Faroese diet was 10.4 S.U., and the mean daily intake was 17.2 pCi ^{90}Sr.

Table 3.2

Estimate of the mean content of ^{137}Cs in the human diet in the Faroes in 1975

Type of food	Annual quantity in kg	pCi ^{137}Cs per kg	Total pCi ^{137}Cs	Percentage of total ^{137}Cs in food
Milk and cream	146	150	21900	21.4
Cheese	7.3	4.4	32	0.0
Grain products	80	25	2000	2.0
Potatoes	91	325	29575	28.9
Vegetables	20	3	60	0.1
Fruit	18	2	36	0.0
Meat and eggs	37	1292	47804	46.6
Fish	91	8	728	0.7
Coffee and tea	7.3	37	270	0.3
Drinking water	548	0.1	55	0.0
Total			102460	

The mean annual intake of potassium is estimated to be approx. 1200 g. Hence the pCi ^{137}Cs/g K ratio becomes 85 and the daily intake of ^{137}Cs 281 pCi.

3.11. Discussion

Figure 3 shows the Faroese diet levels since 1962.

The 1975 ^{90}Sr levels in the total diet were a little higher than in 1974, and the ^{137}Cs levels were somewhat higher due to the higher levels in the samples of lamb from this year.

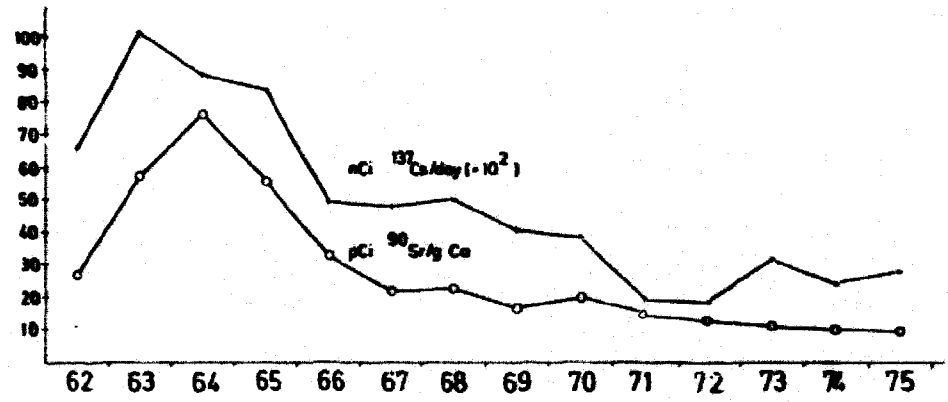

Fig. 3. Strontium-90 and Caesium-137 in Faroese diet, 1962-75.

The main contributors to the ^{90}Sr content in the Faroese diet were milk products, cereals and potatoes, which together accounted for approx. 4/5 of the total ^{90}Sr content in the diet in 1975. As regards ^{137}Cs, milk products, meat (lamb), and potatoes were the most important contributors. In 1975, 97% of the total ^{137}Cs content in the diet originated from these products.

The Faroese mean diet contained 1.9 times as much ^{90}Sr and approx. 16 times as much ^{137}Cs as the Danish diet in 1975[2].

4. CONCLUSION

4.1.

The ^{90}Sr fall-out rate in the Faroes in 1975 was approx. 1.1 mCi $^{90}Sr/km^2$. The accumulated fall-out by the end of 1975 was estimated at approx. 96 mCi $^{90}Sr/km^2$ (the mean at Thorshavn and Klaksvig).

4.2.

The mean level of ^{90}Sr in Faroese milk was 19 S.U. or 23 pCi $^{90}Sr/l$. The ^{137}Cs concentration was 117 pCi $^{137}Cs/g$ K, or 198 pCi $^{137}Cs/l$.

Lamb contained 19 pCi $^{90}Sr/kg$ and 2.57 nCi $^{137}Cs/kg$. Fish showed mean levels of 0.6 pCi $^{90}Sr/kg$ and 11 pCi $^{137}Cs/kg$.

The mean content of ^{90}Sr in drinking water was 0.37 pCi/l.

The mean daily per capita intakes resulting from the Faroeses diet in 1975 were estimated at 17 pCi ^{90}Sr (10 S.U.) and 281 pCi ^{137}Cs (85 pCi $^{137}Cs/g$ K).

4.3.

From the Faroese and Danish diet estimates and from measurements on Faroese and Danish bones, the Faroese bone levels in 1975 were estimated as follows: in newborn infants: approx. 2.5 S.U.; in small children (1 month - 4 years): approx. 3 S.U. (depending upon the amount of locally produced milk in the diet of the infants); in children and teenagers (5 - 19 years): approx. 3 S.U.; in adult vertebrae: approx. 2 - 3 S.U.

The mean content of ^{137}Cs in the Faroese adult was estimated at approx. [illegible] - 100 pCi ^{137}Cs/g K. This estimate is based on whole-body measurements of six adults in 1974 and on the diet estimates in 1974 and 1975.

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